Future Direction

Introduction

The science of site investigation has advanced dramatically in the past 20 years. Advancements in field detection equipment and laboratory analyses have revealed new information about the problems at waste sites.

SITE Program Partners
- **DOD Environmental Security and Technology Certification Program (ESTCP)**
- **DOE Office of Science and Technology**
- **EPA Office of Solid Waste and Emergency Response**
- **EPA Regional Offices**

In addition, years of experience in the cleanup of hazardous waste sites have shown that quick, inexpensive solutions are usually elusive. As a remediation proceeds, the task of site cleanup is often found to be much greater and much more complex than was originally expected. Thus the improvements in site investigation and the lessons learned from both successful and unsuccessful site remediation have demonstrated a great demand for effective innovative technologies.

A number of promising technologies based on sound scientific principles, but lacking engineering and performance documentation, are appearing on the horizon. Some of these, described below, are being studied under the SITE Program, and by the U.S. Department of Energy, U.S. Department of Defense, and others. It is likely that field demonstrations may occur within the next few years for these technologies or for second-generation improvements of these techniques.

The SITE Program continues to emphasize the importance of first selecting a site and, secondly, evaluating one or more appropriate innovative technologies. The selection of these sites and technologies is important in meeting the needs of those responsible for selecting and implementing hazardous waste cleanup. Over the past several years the SITE program has been focusing on in-situ techniques. A wide range of representation from relevant federal and state agencies helps ensure that the most pressing issues are prioritized and addressed.

In response to stakeholders demand, the MMT Program initiated a series of demonstrations designed to evaluate innovative sampling and analysis technologies. The MMT Program has identified a number of possible candidate technologies for demonstration in FY02. One category of technology is testing mercury in soil. In addition, similar dioxin testing has also been planned for FY02. These projects are designed to address ongoing difficulties in obtaining representative samples at defined depths, or obtaining accurate analytical results using less expensive and less complex equipment.

Technology Areas of Primary Interest

One of the critical needs for remediation technology is for methods to accelerate aquifer cleanup. Groundwater contamination may consist of dissolved-phase contaminant plumes, light non-aqueous phase

liquids (LNAPLS), and dense non-aqueous phase liquids (DNAPLS), all of which can potentially move in different directions. As the complexity of the geological formation increases so does the need for innovative technologies to treat or detect non-aqueous phase contamination in groundwater. New technologies are needed to control and remediate this widespread problem.

In addition to groundwater contamination, The SITE Program continues to place priority on evaluating technologies for treatment of metals and/or recalcitrant organic compounds in soil. In situ technologies for either soil or groundwater continue to remain a priority for the SITE Program.

Because of technical difficulties related to sediment remediation, this is another area where the remediation community would benefit from new processes, approaches or less-expensive methods for treatment. In situ treatment, sampling and containment are technology areas of interest that will be addressed in the future.

More recently there have been significant technology breakthroughs in chemical conversion methodologies. Technologies that rely on chemical conversion of the contaminant species rather than destruction or stabilization will end the remediation process at treatment. Metal enhanced dechlorination or treatment barriers fall into this category. This technology is a groundwater treatment technique that degrades chlorinated volatile organics (VOCs) using an electrochemical process that oxidizes granular iron while reducing and dechlorinating VOCs. Two methods of in-situ metal enhanced dechlorination have been developed: in situ permeable treatment trenches (including funnel and gate configurations) and reactor vessels containing granular iron and located in the subsurface. In the future, material other than iron will be assessed for effectiveness on VOCs and other groundwater contaminants.

The SITE Program emphasizes the need for technologies capable of in situ remediation of dense non-aqueous phase liquids (DNAPLs) in difficult geological formations. This continues to be a theme through the remediation community as a whole. The program continues to evaluate in-situ thermal and chemical oxidation type technologies under a broad array of geological conditions. In addition, effective remediation technologies for metals in soils, treatment of recalcitrant compounds, and the general need for in-situ treatment remain high on the priority list.

The SITE Program will also continue to emphasize the need for technologies that focus more on types of contaminated sites rather than single contaminants (i.e., wood preserving sites, manufactured gas plant sites). Most sites are not contaminated with a single contaminant, but with mixtures including by-products formed from normal degradation. Recent applications have lead the SITE Program to move in this direction. Based on the multi-agency review board, a list of new areas are:

- Sediments
- Mining Issues\Acid Mine Drainage
- Manufactured Gas Plants
- Wood Treating\Preserving
- Pesticide Manufacturers\Formulators

Table 3 outlines the future contaminant areas of interest, and Table 4 describes the demonstrations that are planned for FY 02.

Table 3. Future Contaminant Emphasis Areas 2002 - 2007	
Groundwater\Surface Water	**Sediments\Soils**
DNAPL\ Chlorinated Solvents PCBs Arsenic, Mercury or other Heavy Metals	Pesticides PCBs PAHs Arsenic, Mercury, or other Heavy Metals

Table 4. SITE Program Projects FY 02			
Site Name/ Location	**Technology/Developer**	**Project Description**	**Proposed Schedule**
Rocky Mountain Arsenal	In situ heat	Treatment of Hexachlorocyclopentadiene soil contamination	Demonstration FY02-03
Former Manufactured Gas Plant Site Millville,NJ	Ex situ Biotreatment reactor technique	Comingled groundwater plume contaminated with PAHs, MTBE and BTEX	Demonstration FY02-03
Jones Island CDF Milwaukee Harbor	Phytoremediation	Treatment of sediments contaminated with PAHs, PCBs for beneficial reuse	Demonstration FY 02-03
Summitville, CO	Multiple innovative passive drainage techniques	Treatment of acid mine drainage	Demonstration FY01-03
Port of Ridgefield Ridgefield, WA	In situ steam heating	Groundwater and soils contaminated with DNAPL	Demonstration FY02-03
Cape Canaveral Cocoa Beach, FL	In situ reactive iron slurry	Groundwater and soils contaminated with TCE	Technology demonstration FY02-03
Cape Canaveral Cocoa Beach, FL	In situ biological treatment	Groundwater and soils contaminated with TCE	Technology demonstration FY02-03
Loring AFB Caribou, ME	In situ steam	DNAPL treatment in fractured bedrock	Technology demonstration summer FY02-03
Pearl Harbor Naval Base	Multiple in situ capping techniques	Evaluate biological and stabilization\detoxification techniques	Demonstration planning to begin summer FY 02

MMT Program Areas of Interest

The Monitoring and Measurement Technologies Program will continue to test and evaluate in situ and ex situ field analytical technologies, sampling techniques, and methods for the determination of the chemical and physical properties of hazardous waste sites. The schedule of field demonstrations have kept pace with the emergence of new technologies. Input from clients and developers shows an ongoing need to explore new applications which support the goals of the SITE Program. In particular, there remain many monitoring and measurement technology needs including the detection and measurement of organic compounds in the subsurface (particularly LNAPLs and DNAPLs).

Technologies are emerging that show promise for DNAPL detection, but they may not be ready for testing until 2003 or 2004. There is a demand for non-invasive technologies that can be used to detect the presence of contaminants in the subsurface as well as to image the hydrogeologic properties of sites. The detection and measurement of mercury in soil has also been identified as a technology area of considerable interest. The MMT Program will be testing as many as nine technologies which address this need during FY02. The measurement of dioxin has typically required that samples be analyzed in fixed laboratories using prescribed, labor-intensive analytical methods. During FY02, a survey was conducted to identify a number of emerging technologies that may be used to detect and possibly quantify the concentration of dioxin in soil. Some of these technologies will be considered for a field demonstration in FY03.

The use of biological test kits which can determine the toxicity of environmental media will also be considered for demonstration. Biosensor and microelectronic devices represent areas of intense research interest. The first candidates from this class of technologies will be ready for testing in FY04.

Since the program has matured, a number of developers in the area of X-ray fluorescence and gas chromatography /mass spectrometry have made significant improvements in their technology and will be candidates for abbreviated demonstrations which will evaluate the improvements. These demonstrations will be conducted in FY 03 and FY04.

Partnerships for Success

Federal to Federal Interface

The SITE Program will continue to recognize the importance of cooperation between federal agencies to find common areas of need and interest. Interfacing with other federal agencies is an important aspect of enhancing the benefits of technology demonstrations. It allows for leveraging resources, expedited performance and cost information exchange and cross fertilization of technical expertise between agencies. In addition, this type of collaboration encourages the implementation of innovative approaches by federal end users in a more expedited manner and, in many cases, implementation at other non-federal site locations.

One example of shared interest is in DNAPL contamination in the subsurface. It is an environmental problem shared by many of the member agencies of the Federal Remediation Technologies Roundtable (FRTR). These agencies have a mutual interest in finding cost-effective solutions to the characterization, treatment and monitoring of their DNAPL sites.

In 1997, NASA, DOE, EPA and DoD joined forces in forming the Interagency DNAPL Consortium (IDC) in order to evaluate a variety of DNAPL treatment technologies at a site on Cape Canaveral, Florida. These agencies, under the auspices of the FRTR, believe that they should expand on the concept of the IDC by formation of the **Fe**deral **D**NAPL **T**echnologies **I**nitiative

Program (FeDTIP). Our vision is for FeDTIP to be a cooperative program with objectives broadly focused on finding cost-effective technologies for treating DNAPL contamination across a spectrum of site conditions.

The primary objectives of the FeDTIP are to:

- Develop linkages among the many federal DNAPL science and technology activities currently ongoing; the goal is to be complementary rather than duplicative of these activities.

- Sponsor and participate in technology demonstrations and deployments at federal DNAPL sites representing a variety of site conditions to gain cost and performance data.

- Identify the key science and technology issues resulting from demonstrations and deployments that must be resolved in order to reduce costs and improve performance of DNAPL site cleanup.

- Develop or participate in development of technical practices and design guidance manuals for key DNAPL technologies that will become the standard for application at all federal sites.

- Develop an effective technology transfer process for the benefit of the broader DNAPL remediation and regulatory community.

To date, three technologies have been demonstrated at Cape Canaveral Air Station Launch Complex 34. The SITE Program will lead the solicitation for new DNAPL sites during FY 02. New project selections and starts are scheduled for FY 03.

Federal to State Interface

Where there are common environmental areas of interest, it is equally important to have federal to state interactions as it is to have federal to federal cooperation. Cooperation with organizations such as the Environmental Council of States (ECOS) and Interstate Technology Regulatory Council (ITRC) promotes partnerships and builds confidence within the environmental community that proven innovative technology can provide more-effective and less-expensive environmental protection.

The ITRC provides a mechanism to interact with multiple state regulatory agencies and state specific verification programs. The ITRC is a state-led national coalition dedicated to achieving better environmental protection through the use of innovative technologies.

ECOS champions the role of states in environmental management and allows for the exchange of ideas, views, and experience among states. This year the waste committee was working on a resolution to encourage Federal support for interstate technology and regulatory cooperation. This resolution specifically acknowledges the SITE Program, for the demonstration of innovative technologies and their associated cost savings. The resolution was voted and signed unanimously by all ECOS commissioners.

Direct interaction with multiple state agencies provides many benefits. State regulatory agencies are also faced with the difficult problems associated with hazardous waste clean-up, and the variation of regulations among states. Interaction among multiple states on SITE projects can result in multiple technical issues being addressed in one field demonstration. This reduces duplication of field demonstrations to answer one or more state specific regulatory questions.

The ITRC currently has several workgroups that crosscut the SITE Program's environmental priority areas of interest. The various groups are as follows: 1) Permeable Reactive Barrier Workgroup, 2) DNAPL Workgroup, 3) Phytoremediation Workgroup 4) Sediment Workgroup. These groups are

and will continue to be invited to participate in SITE Program demonstration projects. Groups choose to participate at a level required by the objectives of the workgroup. Involvement of the workgroups allows for better planning and exchange of technical requirements early in the planning of SITE projects.

Information Transfer

Information transfer is accomplished through a number of mechanisms. While the internet information distribution is an effective mechanism, published documentation, meetings, and conferences remain an essential part of technical information dissemination.

Coordination with existing remediation workgroups and programs is also essential. The SITE Program continues to work cooperatively with numerous programs, such as DOD's ESTCP Program, the Environmental Council of States (ECOS) sponsored ITRC, and as stated previously plans a much stronger technical relationship with the DOE's Office of Science and Technology.

ITRC Team meetings and special site tours have been conducted near SITE Program field demonstrations in order to capitalize on multiple State participation. In FY 01, the SITE Program, ITRC and NAVY, hosted a tour of Pearl Harbor during the annual ECOS meeting. The general purpose of the tour was to highlight the ongoing partnership between SITE and the ITRC. Approximately 40 people attended the tour. Participants, included State Commissioners, ECOS staff, EPA Regional Administrators, members of Governor Whitman's staff, Navy and DOE officials. The tour highlighted several in-situ and ex-situ demonstrations of innovative technologies that have undergone or will undergo SITE evaluation.

The program will continue pursuing and supporting the development of document summaries in areas where data exists on a variety of technologies or applications. The information is useful in providing the user community with comparative technical information and costs within an area. Documentation will continue for some time since many of the technologies are in situ and highly complex. In situ technology evaluations are tested over varying lengths of time, with a minimum time period of 3-6 months. Most are evaluated for one year. In the case of biological treatment or in-situ capping techniques demonstrations may span 2-3 years. The summaries will need updating as the technologies mature and information becomes available.

Conclusions

The SITE program is a key element in EPA's efforts to increase the availability and use of innovative technologies for remediation of the nation's hazardous waste sites. The SITE Program technology evaluations are used by the remediation community to choose cleanup technology options, and those data are credible because of the rigorous quality assurance and careful planning of the demonstrations. Some technologies once considered innovative have been accepted as standard in part because of this program. Superfund site managers, who in 1986 had the choice of incineration or landfilling, can now find many other tools in the "remediation toolbox." SITE continues to look to the future for innovative solutions to solve the cleanup challenges of the past.

http://www.epa.gov/ORD/SITE